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CUTTING INSERT FOR TURNINGBackground of the Invention

The present invention relates to an indexable insert for turning which cutting insert has a polygonal basic form including an upper surface, and a bottom surface. The top and bottom surfaces are interconnected by side surfaces, wherein at least a part of the intersection lines between the side surfaces and the upper surface forms at least one main cutting edge, a secondary cutting edge and a curved corner cutting edge therebetween.

For copy turning nowadays, to a large extent, indexable inserts are used with nose point angles below 60° , wherein an ordinary value [on] of the nose point angles is 55° , which enables application of the cutting inserts within a broad range. On the market nowadays a number of different types of indexable inserts with 55° nose point angle are found, among which types rhomboidic, rhombic and regular triangular indexable inserts can be mentioned.

In copy turning the following properties regarding feature and economy are desirable:

- 1) Good chip control, i.e. favourable chip guidance and chip breaking.
- 2) No movement of the cutting insert under impact of cutting forces.

When copy turning inwards in certain materials or in slender work pieces and also in usage on unsteady machines and in internal metal working, low cutting forces and preferably a positive chip angle on the copying insert are also desirable. Simultaneously there is a demand in modern machines that the copy turning insert to be used will be able to give the best possible surface finish of the machined surface. Sometimes the

-2-

surface finish can be improved by using higher cutting speed and neutral or positive rake angles.

Objects and Summary of the Invention

5 It is a first purpose of the invention to achieve a new and improved indexable insert for copy turning having a new type of wiper edge in the corner region which enables attainment of improved surface finish of the machined surface.

10 It is a second purpose to achieve an insert with a rake face in the corner area that brings about a favourable influence on the cutting force and the tool wear.

It is a third purpose to achieve an insert that is modified such that it enables increased feed whilst maintaining good surface finish.

15 The present invention relates to an indexable cutting insert having a polygonal shape and including an upper surface, a lower surface, and an edge surface structure interconnecting the upper and lower surfaces. An intersection between the edge surface structure and the top surface forms: a main cutting edge, a secondary cutting edge, and a curved corner region disposed between the main and secondary cutting edges. The corner region includes a radial edge and a corner edge of mutually different radii of curvature. The radial edge and the secondary cutting edge are disposed on a first side of a bisector of the corner region. The corner edge and the main cutting edge are located on a second side of the bisector. A radius of curvature of the radial edge is at least five times larger than a radius of curvature of the curved edge. The top surface includes an edge-reinforcing land extending along the radial edge and the curved edge. A portion of the

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land extending along the radial edge being of smaller width than a portion of the land extending along the curved edge.

Brief Description of the Drawings

The invention will be described in more detail in the following with reference to the enclosed drawings, wherefrom the features of the invention will become apparent.

Fig. 1 is a plan view of a portion of an indexable insert according to the invention.

Fig. 2 is a side view of the cutting insert in Fig. 1.

Fig. 3 is an enlarged detailed view of the corner of an insert according to Figs. 1-2.

Fig. 4 is a view showing a tool with the cutting insert of Figs. 1-3 during copy turning inwards of a work piece.

Fig. 5 shows a sectional view along the line V-V in Fig. 1 and

Fig. 6 is a sectional view along the line VI-VI in Fig. 1.

Detailed Description of Preferred Embodiment of the Invention

Figs. 1-3 show a cutting insert 10 for copying turning according to the invention with triangular basic form. The cutting insert is generally made of cemented carbide but can also be made of other ceramic materials. The insert comprises flat top and bottom surfaces 11 and 12, which are mutually parallel and which form a right angle with the edge surfaces which are designated 13, 14 and 15 and interconnected by curved corner portions. In the embodiment shown in Figs. 1-3 each of the edge surfaces [are] is oriented in a plane perpendicular to the [plane that includes] planes that include the flat surfaces 11 and 12. The insert additionally includes a

-4-

plurality of cutting edges 18, 19[,] which provide intersections between the edge surfaces 13, 14, 15 and the top surface 11. The insert can alternatively have positive basic shape wherein the edge surfaces intersect with the top surface at an acute angle. The insert has a central hole 16 for the receipt of a pin or a centre screw (not shown) for the clamping of the insert into a belonging tool holder 17 (Fig. 4).

In Fig. 3 [1] the edge [surface extending towards an acute-angled corner are designated 13 and 14, with the embodiment shown in Fig. 1 the edge] 18 represents a secondary cutting edge and the edge 19 represents a main cutting edge between which there [then] is an asymmetric curved corner region including a radial edge 20 on one side of the bisector B intended to serve as a wiper edge and on opposite side of said bisector there is a corner edge 21 adjacent to the main cutting edge 19. It is to be understood that the insert must have such inclination that a clearance angle is obtained at the main [cutting edge and at the] and secondary cutting edges 18, 19 and at the corner region therebetween. This will enable the edge portion 20 to be used as an edge for inwards copying such that when facing at for example 90° a large cut can be taken while the length of the edges 18 need not be specifically great. The insert is provided at all cutting edge portions [provided] with a land 22 which extends all around the insert whilst oriented substantially perpendicular towards the edge surface 13, 14, 15.

According to the invention the radial edge 20 is provided with a [size of] radius that is at least five times larger than the size valid for the corner edge 21 located on the opposite side of said bisector B, said corner edge being a transition to the main cutting edge 19. A further characteristic

-5-

feature is that the main cutting edge 19 extends in a longitudinal direction such that it includes an angle of 80-135° together with radial edge 20.

5 The transition between the primary radial edge 20 and the corner edge 21 is in the form of a secondary radial edge 23, the size of which ought to [be] have a radius less than that of the radial edge 24 that represents a transition between the primary radial edge 20 and the secondary cutting edge 18. The relation should preferably be such that the size of the radius of radial edge 23 is about half the size of the radius of radial edge 24 located next to the secondary edge 18. At the same time, a transition radial edge 25
10 ought to be provided between the corner edge 21 and the main cutting edge 19, the radius of which ought to be of same size as the size of the radius of radial edge 24 located next to the secondary edge 18. As regards the width of the land 22 along radial edge 20 and along the remainder of the insert, it has been found suitable to select the width of the portion of said land 22 that extends along radial edge 20 such that it amounts to 50-70 % of the width of
15 the portion of the land 22 that extends along the corner cutting edge 21.

A sloping surface or downwards inclined surface 26 extends from the inner limiting edge of each land 22 and extends into a secondary sloping surface 27 which is located at the corner area. This secondary sloping
20 surface 27 extends into a planar central floor surface 28 of triangular basic shape [whilst] while oriented plane parallel with the bottom face 12 of the insert. The angle of inclination α of said sloping surface 26 ought to be in the [area] range of 10-30° whereas the angle of inclination of the secondary sloping surface 27 ought to be 0-15°.

25 Each land 22 is planar and includes a raised land area, which in a direction away from the corner area extends into an inclined land area. A characteristic feature of the invention is that said land area 22 includes an

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area 22' with smaller width along the radial edge 20 which then successively appears with larger width which is uniform both along the corner cutting edge 21 as well as along the entire main cutting edge 19. At the same time as this brings about a purposeful enforcement of the cutting edge, this simultaneously enables reducing the contact between the chips and the insert's surface such that the crater wear effect can be timely deferred.

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In order to furthermore improve chipbreaking and [deflecting] deflection of the chip obtained during turning and copying, a chip former is provided in the corner region. This chipformer is provided in the shape of an inclined plateau 27 that is depressed in relation to the edge portions, the confining side surfaces of which converge towards the corner with an asymmetric configuration in relation to the bisector. More specifically the shape is such that an essentially [sine-formed] sine wave-shaped side edge 29 located on same side of the bisector B as the primary radial edge 20 gets a termination in the form of an inclined primary edge 30. That edge 30 [which] extends parallel with the radial edge 20 and then provides an obtuse angled corner 31 and then extends into a secondary edge 32 in the opposite direction whereby said bisector B intersects said latter edge approximately in the middle thereof. The last mentioned secondary edge 32 provides in its turn an obtuse angled corner 33 together with the forward termination of another mainly [sine-formed] sine wave-shaped side edge 34 which represents a side confining edge of the plateau 27.

Thanks to the above defined radial differentiation in the corner region of the insert a surprisingly good surface smoothness of the machined surface has been achieved in comparison with a similar insert of constant corner radius, and the insert has additionally been found less sensible to how the setting angle is provided compared with a corresponding insert with

-7-

a straight wiper edge. Due to the above optimized shape of the chipformer in combination with the shape of said land 22 it has simultaneously been possible to increase the feed [with] by 20-100% whilst maintaining the profile depth of the generated surface.

5 In Fig. 4 it is shown how the illustrated embodiment of the insert is used for copying inwards with the insert clamped into [a belonging] an associated toolholder 17 whereby the direction of machining is designated P on the workpiece A.

10 In order to achieve optimized chip control the radii of the various radial edges should lie in the following intervals:

- 20: 5-30 mm, preferably 10-20 mm
- 21: 0.2-3.2 mm, preferably 0.4-1.6 mm
- 23: 0.2-1.6 mm, preferably 0.4-1.2 mm
- 24: 0.6-2.4 mm, preferably 0.8-1.6 mm
- 15 25: 1.6-30 mm, preferably 5-20 mm

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Cutting insert for turning

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25 able to give the best possible surface finish of the machined surface. Sometimes surface finish can be improved by using higher cutting speed and neutral or positive rake angles.

It is a first purpose of the invention to achieve a new and improved indexable insert for
30 copy turning having a new type of wiper edge in the corner region which enables attainment of improved surface finish of the machined surface.

It is a second purpose to achieve an insert with a rake face in the corner area that brings about a favourable influence on the cutting force and the tool wear.

It is a third purpose to achieve an insert that is modified such that it enables increased
5 feed whilst maintaining good surface finish.

The invention will be described in more detail in the following with reference to the enclosed drawings, wherefrom the features of the invention will become apparent.

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Fig. 3 is an enlarged detailed view of the corner of an insert according to Figs. 1-2.

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Fig. 6 is a sectional view along the line VI-VI in Fig. 1.

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Figs. 1-3 show a cutting insert 10 for copying turning according to the invention with triangular basic form. The cutting insert is generally made of cemented carbide but can
20 also be made of other ceramic materials. The insert comprises flat top and bottom surfaces 11 and 12, which are mutually parallel and which form a right angle with the edge surfaces which are designated 13, 14 and 15 and interconnected by curved corner portions. In the embodiment shown in Figs. 1-3 the edge surfaces are oriented in a plane perpendicular to the plane that includes flat surfaces 11 and 12. The insert additionally
25 includes a plurality of cutting edges 18, 19 which, provide intersections between the edge surfaces 13, 14, 15 and the top surface 11. The insert can alternatively have positive basic shape wherein the edge surfaces intersect with the top surface at an acute angle. The insert has a central hole 16 for the receipt of a pin or a centre screw (not shown) for the clamping of the insert into a belonging tool holder 17 (Fig. 4).

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In Fig. 1 the edge surfaces extending towards an acute angled corner are designated 13 and 14, with the embodiment shown in Fig. 1 the edge 18 represents a secondary cutting

edge and the edge 19 represents a main cutting edge between which then is an asymmetric curved corner region including a radial edge 20 on one side of the bisector B intended to serve as a wiper edge and on opposite side of said bisector there is a corner edge 21 adjacent to the main cutting edge 19. It is to be understood that the insert must have such inclination that a clearance angle is obtained at the main cutting edge and at the secondary cutting edges 18, 19 and at the corner region therebetween. This will enable the edge portion 20 to be used as an edge for inwards copying such that when facing at for example 90° a large cut can be taken while the length of the edges 18 need not be specifically great. The insert is at all cutting edge portions provided with a land 22 which extends all around the insert whilst oriented substantially perpendicular towards the edge surface 13, 14, 15.

According to the invention the radial edge 20 is provided with a size of radius that is at least five times larger than the size valid for the corner edge 21 located on the opposite side of said bisector B, said corner edge being a transition to the main cutting edge 19. A further characteristic feature is that the main cutting edge 19 extends in a longitudinal direction such that it includes an angle of 80-135° together with radial edge 20.

The transition between the primary radial edge 20 and the corner edge 21 is in the form of a secondary radial edge 23, the size of which ought to be less than the radial edge 24 that represents a transition between the primary radial edge 20 and the secondary cutting edge 18. The relation should preferably be such that the size of radius of radial edge 23 is about half the size of radial edge 24 located next to the secondary edge 18. At same time a transition radial edge 25 ought to be provided between the corner edge 21 and the main cutting edge 19, the radius of which ought to be of same size as the size of the radius of radial edge 24 located next to the secondary edge 18. As regards the width of the land 22 along radial edge 20 and along the remainder of the insert it has been found suitable to select the width of said land 22 along radial edge 20 such that it amounts to 50-70 % of the width of the land 22 along the corner cutting edge 21.

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A sloping surface or downwards inclined surface 26 extends from the inner limiting edge of each land 22 and extends into a secondary sloping surface 27 which is located at

the corner area. This secondary sloping surface 27 extends into a planar central floor surface 28 of triangular basic shape whilst plane parallel with the bottom face 12 of the insert. The angle of inclination α of said sloping surface 26 ought to be in the area 10-30° whereas the angle of inclination of the secondary sloping surface 27 ought to be 0-15°.

Each land 22 is planar and includes a raised land area, which in a direction away from the corner area extends into an inclined land area. A characteristic feature of the invention is that said land area 22 includes an area 22' with smaller width along the radial edge 20 which then successively appears with larger width which is uniform both along the corner cutting edge 21 as well as along the entire main cutting edge 19. At the same time as this brings about a purposeful enforcement of the cutting edge this simultaneously enables reducing the contact between the chips and the insert's surface such that the crater wear effect can be timely deferred.

In order to furthermore improve chipbreaking and deflecting the chip obtained during turning and copying a chip former is provided in the corner region. This chipformer is provided in the shape of an inclined plateau 27 that is depressed in relation to the edge portions, the confining side surfaces of which converge towards the corner with an asymmetric configuration in relation to the bisector. More specifically the shape is such that an essentially sine-formed side edge 29 located on same side of the bisector B as the primary radial edge 20 gets a termination in the form of an inclined primary edge 30 which extends parallel with radial edge 20 and then provides an obtuse angled corner 31 and then extends into a secondary edge 32 in opposite direction whereby said bisector B intersects said latter edge approximately in the middle thereof. The last mentioned secondary edge 32 provides in its turn an obtuse angled corner 33 together with the forward termination of another mainly sine-formed side edge 34 which represents a side confining edge of the plateau 27.

Thanks to the above defined radial differentiation in the corner region of the insert a surprisingly good surface smoothness of the machined surface has been achieved in comparison with a similar insert of constant corner radius, and the insert has

additionally been found less sensible to how the setting angle is provided compared with a corresponding insert with a straight wiper edge. Due to the above optimized shape of the chipformer in combination with the shape of said land 22 it has simultaneously been possible to increase the feed with 20-100 % whilst maintaining the profile depth of the generated surface.

In Fig. 4 it is shown how the illustrated embodiment of the insert is used for copying inwards with the insert clamped into a belonging toolholder 17 whereby the direction of machining is designated P on the workpiece A.

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In order to achieve optimized chip control the radii of the various radial edges should lie in the following intervals:

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